National Climatic Data Center

DATA DOCUMENTATION

FOR

DATA SET 9640 (DSI-9640)
TIME BIAS CORRECTED DIVISIONAL
TEMPERATURE-PRECIPITATION-DROUGHT INDEX

December 17, 2002

National Climatic Data Center
151 Patton Ave.
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1. Abstract: The National Climatic Data Center (NCDC) maintains and routinely publishes monthly averages of temperature and precipitation for state climatic divisions in the publication <u>Climatological Data</u> (US Dept. of Agriculture, 1931-40, US Dept. of Commerce, 1940-82). The climatic divisions represent a region within a state that is, as nearly as possible, climatically homogeneous. Obviously, in a complex terrain rather extreme variations can occur, but usually the standardized departures from the normal are spatially consistent within a division.

The Palmer model was calibrated over the period 1931-83. Input consisted of monthly mean temperature and total precipitation for each of the 344 state climatic divisions. Prior to 1931, divisional averages were obtained by a series of regression equations relating statewide monthly temperature and precipitation to divisional values. <u>Historical Climatology Series 1-6</u> describes the procedure in detail. Data prior to 1931 should be treated as estimates within each division. Large-scale patterns should be fairly well represented during this time period, but details within a state will be smoothed by the regression estimates.

The major parameters in this file are sequential "Time Biased Corrected" state climatic division monthly Average Temperatures (Deg. F. to 10ths), Precipitation (inches to 100ths), and Palmer Drought Indices (PDSI, PHDI, PMDI, and ZNDX). Period of record is 1895 through latest month available, updated monthly.

Monthly averages within a climatic division have been calculated by giving equal weight to stations reporting both temperature and precipitation within a division. In the U.S., observers at cooperative stations often take one observation per day, and the ending time of the climatological day at any station can vary from station-to-station as well as year-to-year. Differences of the 24-hour period over which each observer reports his or her maximum and minimum temperature as well as the average temperature [(max + min)/2] affect the calculated monthly mean temperature. Karl, et al. (1986), describe the biases that this introduces. These potential biases were rectified by adjusting for these varying observation times. The model described by Karl, et al. (1986), was used to adjust the climate division averages such that all stations end their climatological day at midnight; i.e., climatological day coincides with calendar day. The time of observation was determined at each station within a climate division during January of the years 1931, 1941, 1951, 1965, 1975, and 1984 for the states of California, Colorado, Illinois, Indiana, New York, North Carolina, and Washington. The fraction of observers recording at various hours of the day was calculated and interpolated for intervening years (extrapolated for subsequent years). For these seven states, the ending time of observation was grouped into three categories: AM, PM, and MD. The AM category included observers who ended their climatological day between 3 AM and 11AM; the PM category between noon and 9 PM; and the MD category between 10 PM and 2 AM; all local standard time. The fraction of observers in these categories was calculated, and it was assumed the 7 AM observation time best represented the AM category; the 5 PM observation time, the PM category; and midnight for the MD category. The reason for the simplification was to test if a faster method, requiring significantly less bookkeeping and keypunching, could not provide nearly as good results as calculating the fraction of observers at each of the 24 hours of the day.

The time of observation bias model was run by using the latitude and longitude of each of the centroids of the climate divisions. The output from the model was the time of observation bias, with respect to a midnight-to-midnight climatological day, for each of the possible ending hours of the climatological day. Each climate division's monthly average was then adjusted by weighting

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the bias at any given hour by the fraction of stations within the climate division observing at that hour, and subtracting the result for the reported monthly mean temperature.

Differences of the biases were small (< 0.3 Deg. F.) for those calculated by categorizing the ending time of observation into three categories compared to those obtained from calculating the fraction of stations with observation times at each of the 24 hours of the day. This is attributed to the preponderance of AM observation times falling between 6 AM and 9 AM, and PM observation times falling between 4 PM and 7 PM. As a result, by assuming 7 AM observation for all AM stations and 5 PM for all PM stations, a good estimate of the median bias is obtained for all AM or PM observations. Furthermore, nearly all the MD stations observed at midnight.

It should also be noted that the borders of the climate divisions in 1951 were not consistent with those defined in 1965. Due to the substantial additional effort it would have required locating each station within three or four climate divisions, as defined today, the change in the statewide percentage of AM, PM, and MD observation times was applied in equal proportions to all climate divisions prior to and including 1951.

Based on small differences between the two methods of estimating the time of observation bias, the simpler categorical procedure was used for all climate divisions. This should effectively eliminate most of the biases (over 2 Deg. F.) in some climate divisions that have become part of the divisional averages. These biases affect both trends and actual estimates of divisional averages.

Historical drought data have been added to this file for the period 1895 to present. The file is updated monthly. All drought data are calibrated using the period 1895-1987.

2. __Element Names and Definitions__:

Drought data include:

a. __Palmer Drought Severity Index (PDSI)__

This is the monthly value (index) that is generated indicating the severity of a wet or dry spell. This index is based on the principles of a balance between moisture supply and demand. Man-made changes were not considered in this calculation. The index generally ranges from -6 to +6, with negative values denoting dry spells and positive values indicating wet spells. There are a few values in the magnitude of +7 or -7. PDSI values 0 to -.5 = normal; -0.5 to -1.0 = incipient drought; -1.0 to -2.0 = mild drought; -2.0 to -3.0 = moderate drought; -3.0 to -4.0 = severe drought; and greater than -4.0 = extreme drought. Similar adjectives are attached to positive values of wet spells. This is a meteorological drought index used to assess the severity of dry or wet spells of weather. See file 1 below.

b. __Palmer Hydrological Drought Index (PHDI)__

This is the monthly value (index) generated monthly that indicates the severity of a wet or dry spell. This index is based on the principles of a balance between moisture supply and demand. Man-made changes such as increased irrigation, new reservoirs, and added industrial water use were not included in the computation of this index. The index generally ranges from -6 to +6, with negative values denoting dry spells, and positive values indicating wet spells. There are a few values in the magnitude of +7 or -7. PHDI values 0 to -0.5 = normal; -0.5 to -1.0 = incipient drought; -1.0 to -2.0 = mild drought; -2.0 to -3.0 = moderate drought; -3.0 to -4.0 = severe drought; and greater than -4.0 = extreme drought. Similar adjectives are attached to positive values of wet
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spells. This is a hydrological drought index used to assess long-term moisture supply. See file 2 below.

c. Palmer "Z" Index (ZNDX)

This is the generated monthly Z values, and they can be expressed as the "Moisture Anomaly Index." Each monthly Z value is a measure of the departure from normal of the moisture climate for that month. This index can respond to a month of above-normal precipitation, even during periods of drought.

"Table 1 contains expected values of the Z index and other drought parameters. See Historical Climatology Series 3-6 through 3-9 (NCDC Library) for a detailed description of the drought indices." See file 3 below.

d. Modified Palmer Drought Severity Index (PMDI)

This is a modification of the Palmer Drought Severity Index. The modification was made by the National Weather Service Climate Analysis Center for operational meteorological purposes. The Palmer drought program calculates three intermediate parallel index values each month. Only one value is selected as the PDSI drought index for the month. This selection is made internally by the program on the basis of probabilities. If the probability that a drought is over is 100%, then one index is used. If the probability that a wet spell is over is 100%, then another index is used. If the probability is between 0% and 100%, the third index is assigned to the PDSI. The modification (PMDI) incorporates a <u>weighted average</u> of the wet and dry index terms, using the probability as the weighting factor. (Thomas R. Heddinghause and Paul Sabol, 1991; "A Review of the Palmer Drought Severity Index and Where Do We Go From Here?," <u>Proceedings of the Seventh Conference on Applied Climatology</u>, pp. 242-246, American Meteorological Society, Boston, MA). The PMDI and PDSI will have the same value during an established drought or wet spell (i.e., when the probability is 100%), but they will have different values during transition periods. See file 4 below.

Table 1. Classes for Wet and Dry Periods

Approximate Cumulative Frequency %	PHDI Range	Category	ZNDX Range
≥96	≥ 4.00	Extreme wetness	≥ 3.50
90-95	3.00, 3.99	Severe wetness	2.50, 3.49
73-89	1.50, 2.99	Mild to moderate wetness	1.00, 2.49
28-72	-1.49, 1.49	Near normal	-1.24, 0.99
11-27	-1.50, -2.99	Mild to moderate drought	-1.25, -1.99
5-10	-3.00, -3.99	Severe drought	-2.00, -2.74
≤4	≤-4.00	Extreme drought	≤ -2.75

This data files resides on magnetic tape and contains 6 files separated by end of file marks. The tape is unlabeled.

File 1. Divisional Monthly Palmer Drought Severity Index (PDSI)
        94 characters per record, blocked 100 records per block

File 2. Divisional Monthly Palmer Hydrological Drought Index (PHDI)
        94 characters per record, blocked 100 records per block

File 3. Divisional Monthly Palmer "Z" Index (ZNDX)

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94 characters per record, blocked 100 records per block

File 4. Divisional Monthly Modified Palmer Drought Severity Index (PMDI)
         94 characters per record, blocked 100 records per block

File 5. Divisional Monthly Temperatures
         94 characters per record, blocked 100 records per block

File 6. Divisional Monthly Precipitation
         94 characters per record, blocked 100 records per block

FILE 1. DIVISIONAL MONTHLY PALMER DROUGHT SEVERITY INDEX (PDSI)

Element Name	Record Position	Element Description
FILLER	1	Blank
STATE-CODE	2-3	STATE CODE as indicated in the State-Code Table. Range of values of 01-91.

01	Alabama	28	New Jersey
02	Arizona	29	New Mexico
03	Arkansas	30	New York
04	California	31	North Carolina
05	Colorado	32	North Dakota
06	Connecticut	33	Ohio
07	Delaware	34	Oklahoma
08	Florida	35	Oregon
09	Georgia	36	Pennsylvania
10	Idaho	37	Rhode Island
11	Illinois	38	South Carolina
12	Indiana	39	South Dakota
13	Iowa	40	Tennessee
14	Kansas	41	Texas
15	Kentucky	42	Utah
16	Louisiana	43	Vermont
17	Maine	44	Virginia
18	Maryland	45	Washington
19	Massachusetts	46	West Virginia
20	Michigan	47	Wisconsin
21	Minnesota	48	Wyoming
22	Mississippi	49	Not Used
23	Missouri	50	Alaska
24	Montana	51	Hawaii
25	Nebraska	66	Puerto Rico
26	Nevada	67	Virgin Islands
27	New Hampshire	91	Pacific Islands

Element Name	Record Position	Element Description
DIVISION NUMBER	4-5	Div. # assigned by NCDC. Range of values 01-10
FILLER	6	Blank
YEAR	7-10	Year of the record. Range is 1895 to current year processed.
JAN-VALUE	11-17	JANUARY Divisional Monthly "PDSI". Range of values b-20.00 to bb20.00. Decimal point retains a position in 7-character field.

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		Missing values in the latest year are indicated by -999.99.
FEB-VALUE	18-24	FEBRUARY Divisional Monthly "PDSI".
MAR-VALUE	25-31	MARCH Divisional Monthly "PDSI".
APR-VALUE	32-38	APRIL Divisional Monthly "PDSI".
MAY-VALUE	39-45	MAY Divisional Monthly "PDSI".
JUNE-VALUE	46-52	JUNE Divisional Monthly "PDSI".
JULY-VALUE	53-59	JULY Divisional Monthly "PDSI".
AUG-VALUE	60-66	AUGUST Divisional Monthly "PDSI".
SEPT-VALUE	67-73	SEPTEMBER Divisional Monthly "PDSI".
OCT-VALUE	74-80	OCTOBER Divisional Monthly "PDSI".
NOV-VALUE	81-87	NOVEMBER Divisional Monthly "PDSI".
DEC-VALUE	88-94	DECEMBER Divisional Monthly "PDSI".

FILE 2. DIVISIONAL MONTHLY PALMER HYDROLOGICAL DROUGHT INDEX (PHDI)

Element Name	Record Position	Element Description
FILLER	1	Blank
STATE-CODE	2-3	STATE-CODE as indicated in State Code Table as described in FILE 1. Range of values is 01-91.
DIVISION-NUMBER	4-5	DIVISION NUMBER - Assigned by NCDC. Range of values 01-10.
FILLER	6	Blank
YEAR	7-10	This is the year of record. Range is 1895 to current year processed.
JAN-VALUE	11-17	JANUARY Monthly Divisional "PHDI". Range of values b-20.00 to bb20.00. Decimal point retains a position in 7-character field. Missing values in the latest year are indicated by -999.99.
FEB-VALUE	18-24	FEBRUARY Monthly Divisional "PHDI".
MAR-VALUE	25-31	MARCH Monthly Divisional "PHDI".
APR-VALUE	32-38	APRIL Monthly Divisional "PHDI".
MAY-VALUE	39-45	MAY Monthly Divisional "PHDI".
JUNE-VALUE	46-52	JUNE Monthly Divisional "PHDI".
JULY-VALUE	53-59	JULY Monthly Divisional "PHDI".

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AUG-VALUE	60-66	AUGUST Monthly Divisional "PHDI".
SEPT-VALUE	67-73	SEPTEMBER Monthly Divisional "PHDI".
OCT-VALUE	74-80	OCTOBER Monthly Divisional "PHDI".
NOV-VALUE	81-87	NOVEMBER Monthly Divisional "PHDI".
DEC-VALUE	88-94	DECEMBER Monthly Divisional "PHDI".

FILE 3. DIVISIONAL MONTHLY PALMER "Z" INDEX (ZNDX)

Element Name	Record Position	Element Description
FILLER	1	Blank
STATE-CODE	2-3	STATE-CODE as indicated in State Code Table as described in FILE 1. Range of values is 01-91.
DIVISION-NUMBER	4-5	DIVISION NUMBER - Assigned by NCDC. Range of values 01-10.
FILLER	6	Blank
YEAR	7-10	This is the year of record. Range is 1895 to current year processed.
JAN-VALUE	11-17	JANUARY Monthly Divisional "ZNDX". Range of values b-20.00 to bb20.00. Decimal point retains a position in 7-character field. Missing values in the latest year are indicated by -999.99
FEB-VALUE	18-24	FEBRUARY Monthly Divisional "ZNDX".
MAR-VALUE	25-31	MARCH Monthly Divisional "ZNDX".
APR-VALUE	32-38	APRIL Monthly Divisional "ZNDX".
MAY-VALUE	39-45	MAY Monthly Divisional "ZNDX".

JUNE-VALUE	46-52	JUNE Monthly Divisional "ZNDX".
JULY-VALUE	53-59	JULY Monthly Divisional "ZNDX".
AUG-VALUE	60-66	AUGUST Monthly Divisional "ZNDX".
SEPT-VALUE	67-73	SEPTEMBER Monthly Divisional "ZNDX".
OCT-VALUE	74-80	OCTOBER Monthly Divisional "ZNDX".
NOV-VALUE	81-87	NOVEMBER Monthly Divisional "ZNDX".
DEC-VALUE	88-94	DECEMBER Monthly Divisional "ZNDX".

FILE 4. DIVISIONAL MONTHLY MODIFIED PALMER DROUGHT SEVERITY INDEX (PMDI)

Element Name	Record Position	Element Description
FILLER	1	Blank
STATE-CODE	2-3	STATE-CODE as indicated in State Code Table as described in FILE 1. Range of values is 01-91.
DIVISION-NUMBER	4-5	DIVISION NUMBER - Assigned by NCDC. Range of values 01-10.
FILLER	6	Blank
YEAR	7-10	This is the year of record. Range is 1895 to current year processed.
JAN-VALUE	11-17	JANUARY Monthly Divisional "PMDI". Range of values b-20.00 to bb20.00. Decimal point retains a position in 7-character field. Missing values in the latest year are indicated by -999.99.
FEB-VALUE	18-24	FEBRUARY Monthly Divisional "PMDI".
MAR-VALUE	25-31	MARCH Monthly Divisional "PMDI".
APR-VALUE	32-38	APRIL Monthly Divisional "PMDI".
MAY-VALUE	39-45	MAY Monthly Divisional "PMDI".
JUNE-VALUE	46-52	JUNE Monthly Divisional "PMDI".
JULY-VALUE	53-59	JULY Monthly Divisional "PMDI".
AUG-VALUE	60-66	AUGUST Monthly Divisional "PMDI".
SEPT-VALUE	67-73	SEPTEMBER Monthly Divisional "PMDI".
OCT-VALUE	74-80	OCTOBER Monthly Divisional "PMDI".
NOV-VALUE	81-87	NOVEMBER Monthly Divisional "PMDI".

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DEC-VALUE	88-94	DECEMBER Monthly Divisional "PMDI".

FILE 5. DIVISIONAL MONTHLY TEMPERATURES

Element Name	Record Position	Element Description
STATE-CODE	1-2	STATE-CODE as indicated in State Code Table as described in FILE 1. Range of values is 01-91.
DIVISION-NUMBER	3-4	DIVISION NUMBER - Assigned by NCDC. Range of values 01-10.
YEAR	5-8	This is the year of record. Range is 1895 to current year processed.
JAN-VALUE	9-13	JANUARY Monthly Divisional Temperature Value. Range of values -50.0 to 140.0 degrees Fahrenheit. Decimals retain a position in the 5-character field. Missing values in the latest year are indicated by -99.9.
FEB-VALUE	14-18	FEBRUARY Monthly Divisional Temperature Value.
MAR-VALUE	19-23	MARCH Monthly Divisional Temperature Value.
APR-VALUE	24-28	APRIL Monthly Divisional Temperature Value.
MAY-VALUE	29-33	MAY Monthly Divisional Temperature Value.
JUNE-VALUE	34-38	JUNE Monthly Divisional Temperature Value.
JULY-VALUE	39-43	JULY Monthly Divisional Temperature Value.
AUG-VALUE	44-48	AUGUST Monthly Divisional Temperature Value.
SEPT-VALUE	49-53	SEPTEMBER Monthly Divisional Temperature Value.
OCT-VALUE	54-58	OCTOBER Monthly Divisional Temperature Value.
NOV-VALUE	59-63	NOVEMBER Monthly Divisional Temperature Value.
DEC-VALUE	64-68	DECEMBER Monthly Divisional Temperature Value.
FILLER	69-94	Blanks

FILE 6. DIVISIONAL MONTHLY PRECIPITATION

Element Name	Record Position	Element Description
STATE-CODE	1-2	STATE-CODE as indicated in State Code Table as described in FILE 1. Range of value is 01-91.
DIVISION-NUMBER	3-4	DIVISION NUMBER - Assigned by NCDC. Range of values 01-10.

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YEAR                    5-8      This is the year of record.  Range is 1895 to
                                 current year processed.

JAN-VALUE               9-13     JANUARY Monthly Divisional Precipitation
                                 Value. Range of values 00.00 to 99.99.
                                 Decimal point retains a position in the 5-
                                 character field.  Missing values in the latest
                                 year are indicated by -9.99.

FEB-VALUE               14-18    FEBRUARY  Monthly  Divisional  Precipitation
                                 Value.

MAR-VALUE               19-23    MARCH Monthly Divisional Precipitation Value.

APR-VALUE               24-28    APRIL Monthly Divisional Precipitation Value.

MAY-VALUE               29-33    MAY Monthly Divisional Precipitation Value.

JUNE-VALUE              34-38    JUNE Monthly Divisional Precipitation Value.

JULY-VALUE              39-43    JULY Monthly Divisional Precipitation Value.

AUG-VALUE               44-48    AUGUST Monthly Divisional Precipitation Value.

SEPT-VALUE              49-53    SEPTEMBER Monthly Divisional Precipitation
                                 Value.

OCT-VALUE               54-58    OCTOBER Monthly Divisional Precipitation
                                 Value.

NOV-VALUE               59-63    NOVEMBER Monthly Divisional Precipitation
                                 Value.

DEC-VALUE               64-68    DECEMBER Monthly Divisional Precipitation
                                 Value.

FILLER                  69-94    Blanks
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3.   **Start Date:** 1895.

4.   **Stop Date:** Ongoing. Updated monthly.

5.   **Coverage:** Contiguous United States.

6.   **How to Order Data:**

Ask NCDC's Climate Services about the cost of obtaining this data set.
Phone: 828-271-4800
FAX: 828-271-4876
E-mail: **NCDC.Orders@noaa.gov**

7.   **Archiving Data Center:**

National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

8.   **Technical Contact:**
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National Climatic Data Center
Federal Building
151 Patton Avenue
Asheville, NC 28801-5001
Phone: (828) 271-4800.

9.   Known Uncorrected Problems: No information provided with original documentation.

10.   Quality Statement: No information provided with original documentation.

11.   Essential Companion Datasets: No information provided with original documentation.

12.   References:

Karl, T. R., C. N. Williams, Jr., Pamela J. Young, and Wayne M. Wendland, Journal of Climate and Applied Meteorology, Vol. 25, No. 1, January 1986, American Meteorological Society, Boston, MA.

Heddinghause, T. R., and Paul Sabol, 1991; "A Review of the Palmer Drought Severity Index and Where Do We Go From Here?," Proceedings of the Seventh Conference on Applied Climatology, pp. 242-246, American Meteorological Society, Boston, MA).